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ABSTRACT

This paper reviews several studies on aptitude treatment interaction, the interaction between the learners' individual differences and methods of instruction. Specifically, it investigates the relationship between previous knowledge, including previously held misconceptions, and instructional methods. It is suggested that significant interactions are not easy to achieve. However, one reported study describes the positive interaction between low initial ability or prior knowledge and teaching methods that provide much instructional support (e.g. cues, structure, feedback, etc.). Interaction between learning styles and teaching method is also discussed, specifically a study in which instruction including use of metaphors was helpful to students with a preference for a visual format (visualizers) but not to those with a preference for a verbal format (verbalizers). The article advocates a metacognitive approach to evaluating learning, analyzing the cognitive processes involved in the learning rather than just the outcomes. It also proposes the use of computers to monitor these cognitive processes. (JGL)

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THE ROLE OF PRIOR EXPERIENCE IN LEARNING FROM INSTRUCTION

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THE ROLE OF PRIOR EXPERIENCE IN LEARNING FROM INSTRUCTION.

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INTRODUCTION

After the Sputnik era, higher education focused on the identification and support of those students who showed marked promise for academic progress. Great emphasis was placed on selection of talent. Gradually, there has been a shift, caused by new social priorities, from education mainly for the talented students towards admitting very large numbers of students. Not the selection of talent, but the development of talent was stressed by modern society. With the "free access policy", however, it became difficult to guarantee high standards of education. Due to this policy we are now faced with what has been called "a nation at risk". Today, the critical problem appears to be how to deal effectively with large individual differences in education. This is not a new problem, but a problem that has taken new urgency.

INSTRUCTIONAL ARRANGEMENTS

Commonly, instructional arrangements are designed to promote student learning. Such arrangements are composed of many factors such as presenting, selecting, sequencing and organizing the instructional content, providing feedback, maintaining student attention, and so on. Each of these factors will produce - at least some - effect. But there are alternative ways of presenting materials to the students - some of which are more effective than others. There are many ways of dealing with subject matter - some of which will be more encouraging than others. There are different ways of providing feedback - some of which will lead to more intensive cognitive processing of the instructional content than others. The main point here is to develop an instructional arrangement that maximizes student learning at a minimum of cost in time, effort, and money.
In order to be able to develop appropriate instructional arrangements one should take notice of individual differences. The instructional outcome depends not only on a number of instructional variables, but also on internal conditions of learning, such as learning capacity, motivation, and perseverance. Commonly, by selecting an instructional method or learning materials, the teacher makes an assumption about how learners process the instructional information. But the individual learner may very well use his own strategy for processing information to fit his own capacity, style or preference. When this is the case, then the instructional arrangement must be flexible and adaptive. This means that one has to find or devise alternative educational treatments that fit individual students' aptitude patterns such that common instructional goal attainment is

maximized for each student (and hence, overall utility is gained).

APTITUDE TREATMENT INTERACTION

To find a match between students' aptitudes and treatments is the main purpose of Aptitude Treatment Interaction (ATI) research. Generally speaking, it can be concluded that ATI-research has not been very succesful. It appears that consistently significant interactions are not easy to achieve. A good deal of this difficulty is due to the lack of adequate theories that provide grounds for hypothesizing what sorts of treatment will produce useful interaction. On the other hand, there is little reason to believe that one single instructional variable would interact differentially with one particular aptitude measure in promoting learning. Both students as well as treatments may vary in many different ways. It is likely to assume that higher order interactions will exist between patterns of aptitudes and a combination of treatment variables (see Snow & Lohman, 1984). This may be, at least in part, the reason for the current unproductivity of ATI-research and for the fact that many researchers (and practitioners) are discouraged. They agree that the ATI-model needs reexamination of its operational and conceptual premises.

COGNITIVE ACTIVITIES

A more optimistic note has been struck by Tobias (1982). He hypothesized an interaction between prior achievement and instructional support - the assistance offered to the learner by ways of organizing the instructional content, giving cues, maintaining attention, providing feedback, and so on. Several studies confirmed this achievement-treatment hypothesis (Tobias, 1976, 1981). One of these studies has been done by Van der Sanden & Van Eck-Schouten (1986). They found that students with low relevant initial abilities profit most from high instructional support (e.g. cues, structure, feedback, etc.), whereas students with high ability scores performed better under low instructional support conditions. Under conditions of much assistance, students with high prior ability scores performed even worse than students with low abilities.
However, there were also studies that failed to support this hypothesis. Tobias (1982) offered the following tentative explanation for these negative results: the treatments may not have been sufficiently different with respect to the degree to which they affect the students' cognitive activities while engaged by the instructional content. According to Tobias, differences between instructional treatments are important only in terms of macroprocesses - the frequency and intensity with which students cognitively process the instructional information. He hypothesized that outcome differences occur only when different instructional methods lead students to engage in different macroprocesses. Testing of this hypothesis requires a reorientation of both

treatments and individual differences. Only when individual difference measures are meaningfully related to the macroprocesses the methods require, ATI-findings can be correctly interpreted, i.e., meaningful explanations can be offered about why ATI's are present in one case and fail to appear in the other. This seems to be a promising line of investigation in the area of learning and instruction.

THE ROLE OF PRIOR ACHIEVEMENT IN LEARNING AND INSTRUCTION.

Existing knowledge at the onset of instruction plays a very important role in learning from instruction. A substantial part of our existing knowledge has been acquired during prior formal instruction. In many cases, the learners' prior achievement, defined in terms of their scores on relevant pretests, is considered as a measure of their current mastery level. Since learning builds on learning, it is necessary to assess prior knowledge before the learner proceeds to the next learning task. When it appears that the learner doesn't have the required mastery level, then some supplementary or remedial information must be given.

From the work of Tobias, discussed above, we know that there is much evidence for an inverse relationship between prior knowledge and instructional support. The lower the learners' pretest scores, the more assistance they require to accomplish given instructional objectives.

It is reasonable to assume that not only the amount, but also the kind of instructional support is an important variable accounting for student learning. Most arrangements aim at increasing the learner's cognitive processing. But the internal processes a given method or treatment requires, may interfere with the way in which an indivual learner is used to process information. This has been shown by Simons (1981). In his study, the learning materials consisted of concepts from the science curriculum of primary education. One of his hypotheses was that the connection between existing knowledge and the information to-be-learned, can be improved by using metaphors. By adding metaphors to the written materials, relevant related knowledge from long term memory will be decoded in working memory while encoding the new concepts. Owing to this, connections will be made between existing knowledge and new concepts.

By using metaphors of the type involved in the study of Simons, the existing knowledge will be retrieved in a visual format. However, from the work of Boekaerts (1979) we know that learners may differ in the way in which they preferrably encode and decode information. Some learners show a clear preference for a visual format (i.e., the visualizers), whereas other learners show a preference for a verbal format (i.e., the verbalizers). As expected, Simons found an interaction between instructional treatments and the information processing "style" of the learners. For those learners who were classified as visualizers, the metaphors were an appropriate aid in connecting new concepts to existing knowledge. For verbalizers this was not the case. They were hampered by the supply of metaphors.

This study clearly indicates that the effectiveness of instruction is not only dependent on the amount, but also on the kind of instructional assistance that is given. Another important implication of this study is that relevant existing knowledge is not necessarily restricted to specific prerequisite information, as it is provided by prior instruction and as is formally assessed by means of pretests.

THE ROLE OF PRECONCEPTIONS IN LEARNING AND INSTRUCTION

Commonly, the learner's knowledge serves as a building ground for further instruction. Many concepts that are learned by formal instruction are part of a taxonomy involving prerequisite dependency relationships. But relevant existing knowledge is more than the necessary prerequisites that are derived from a task analysis. It is composed of all experiences and memories that can facilitate the encoding of new concepts in long term memory, provided that they are available for retrieval.

When a learner is confronted with a particular concept, it may occur that he has some idea of its meaning. However, when formally tested, the learner may appear not to have the desired mastery level. The learner may even have idiosyncratic ideas about the meaning of concepts. When formally tested, these preconceptions - as they are referred to - may appear to be incomplete or even invalid.

When new concepts are related to such incomplete or invalid concepts, the learner is at risk to form incorrect concepts or concepts that are not available for approriate use in later situations that call on these concepts. These preconceptions have to be corrected, since they otherwise obstruct the learning process at which instruction is aimed. This is exactly the starting point of a study that is done by Gerritsen van der Hoop (1986). On the basis of a review study he concluded that: "Most authors are almost exclusively interested in the question how the new information is processed, remembered, etc., and not in changes in the existing knowledge. Secondly, it is assumed (explicitly or implicitly) that the existing knowledge is complete, correct, and useful. Recent research shows that this assumption is not always warranted. Learners appear to have incomplete, false, and useless preconceptions about many subjects". According to this author, an essential goal of formal instruction of concepts in various subject fields, must be to modify and correct the learners' preconceptions.

Gerritsen van der Hoop has studied concept achievement in the field of social studies, using concepts such as "power" and "social control". The central question underlying his study was to what extent the learning of such concepts can be improved by making use of the preconceptions of the learner. In the experiments that were carried out, the learners were confronted with a text that contained the relevant information about the concepts to-be-learned. After studying the text, the subjects were confronted with a number of descriptions of all sorts of situations. One of the independent variables was the use of a comparison task. The

subjects in the experimental group were asked to indicate whether they would have judged the situations as positive or as negative instances of the concept to-be-learned (e.g., "social control") before instruction began. The subjects in the control group were not requested to perform such a comparison task. The assumption was that the comparison task forces the learner to activate his (pre)conceptions. If - through comparing the existing knowledge with the factual information in the text - the preconceptions turn out to be misconceptions then the learner will change them to more valid conceptions. The results indicated that the experimental group performed better than the control group. Both conceptual and procedural knowledge improved significantly by supplying a comparison task. The latter appears from the fact that, when confronted with various examples and non-examples of the concept to-be-learned, the members of the experimental group assessed the examples more accurately than the members of the control group.

THE METACOGNITIVE APPROACH

In general, it can be said, that we have little knowledge regarding what a student is doing and thinking while learning from instruction. We also know very little about the extent to which a learner is aware of the cognitive processes the task requires. Or, to put it differently, to what extent are learners able to learn? This is the main (research) question underlying the metacognitive approach (see also Flavell, 1979, and Brown, Campione & Day, 1981). According to this approach, the teacher has to analyse which cognitive activities are required to peform a learning task. The analysis must lead to the design of a training program to instruct naive learners to perform the task. Learners must be encouraged to become active participants in the process of elaborating and organizing information. They have to learn to set goals, to plan, and to see whether the goals are being reached. The learner must ask himself questions such as: "Do I understand it?"; "Can I give a good example of it?"; "What else do I need to know?" "Is this strategy working for me?". Emphasis on such metacognitive activities will lead to improvement of learning from instruction. Tobias (1982) has stated that it is not useful merely to study the effects of different instructional design variables and to monitor achievement or other outcomes. In addition, the types of cognitive processing activities that occur while students are working on instructional materials should be studied. This is exactly what the metacognitive approach is aiming at - the study of processes such as goal setting, strategy selection, evaluation, and remediation. Research in this area will provide useful information for the construction of instructional program. These studies must be sufficiently detailed so that a computer can be used to stimulate and guide task acquisition.
By using a computer it is possible to develop programs that are geared to the metacognitive activities of the learner. Emphasis must not be on teaching strategies but on learning

strategies. The computer is probably most effective when it is monitoring, not the achievement, but the cognitive activities underlying performance. This is referred to as "cognitive monitoring" by Flavell (1979).
Usually, feedback is given in the form of knowledge of results (KR). Essentially, KR is extrinsic, "post performance" feedback about the results, commonly the results of a test that has been administered. It informs the learner that his response or reaction was not correct, so that he can change it to what is (hopefully) more adequate. KR thus guides the learner toward the proper response. But a computer also offers the possibility to provide "knowledge of processes" (KP). KP may help the learner to become aware of what, why, and how he is doing while engaged in the instructional content. It may support the learner to plan, to select a strategy, to detect and diagnose errors, and to find ways to correct them. The computer seems well suited to encourage students to acquire these strategies and skills. They may develop slowly in the beginning and may halt the processing of information for a while, but once these strategies have been obtained, there should be considerable gain in learning.

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